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Study of the charge carrier properties GaAs:Cr with Timepix3

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Recent advantages in crystal growth have facilitated the production of high resistivity (HR) chromium compensated gallium arsenide (GaAs:Cr), which has become an alternative to silicon especially in X- and gammas-ray detection and imaging, where such sensors profit from their higher absorption efficiency. To explore charge transport properties of the material we measured the dependence of the electrons and holes drift velocity on the electric field and the dependence of the diffusion coefficient on the electric field. It became possible by analyzing the detector response to charged particles entering the detector at grazing angle. The holes lifetime and their mobility was measured using the drift time information for the first time for HR GaAs:Cr material to be τ_{h} = 4.5±0.5 ns, μ_{h} = 320±10 cm2/V/s at 300 V. The measured parameters were validated by comparison of the measured and the simulated data for various X- and gammas-ray sources in the energy range of 6 –60 keV, protons of 125 MeV, and pions of 120 GeV/c. The sufficient lifetime of electrons (˜30 ns) and their higher mobility (> 3000 cm2/V/s) in comparison with silicon make the GaAs:Cr sensors interesting tools to fully exploit the timing precision of Timepix3 (i.e. 1.6 ns) in particle tracking applications or for characterization of pulsed X-ray sources.

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